JOHNSON CONTROLS, INC.
812 First State Blvd
Delmarva Branch N28
Wilmington, DE 19804
(302)996-0275

Report of Eddy Current Inspection

Manufacturer: Carrier

Model: 17DA743

Serial: 01588 #6

Location: DUPONT EXPERIMENTAL STATION
200 POWER MILL ROAD
BUILDING 315
WILMINGTON, DE 19803

Inspected: January 21, 2019

Inspected By: JAYSON C. GREER, LEVEL III
TAI Services, Inc.

Reviewed By: _____
TECHNICAL MANAGER, LEVEL III

Table of Contents

Vessel Information

Manufacturer	Model	Style	Serial Number	Type
Carrier	17DA743	Open Drive	01588 #6	Centrifugal

Evaporator	
TestEnd	Opposite Inlet/Outlet
Tube Count	2586
Tube Type	Skip Fin IE
Tube Material	Copper
OD	.750
*NWT/Under Fins	.028
*NWT/Bell/Land	.049
#/Type Support	5 Mild Steel
Tube Numbering	Left to Right
Row Numbering	Top to Bottom
Tube Length +- 2	264 Inches

Analyst: JAYSON C. GREER, LEVEL III

* Nominal Wall Thickness

Vessel Bay Length Information

Evaporator (Length = 264 inches)
S = Intermediate Support

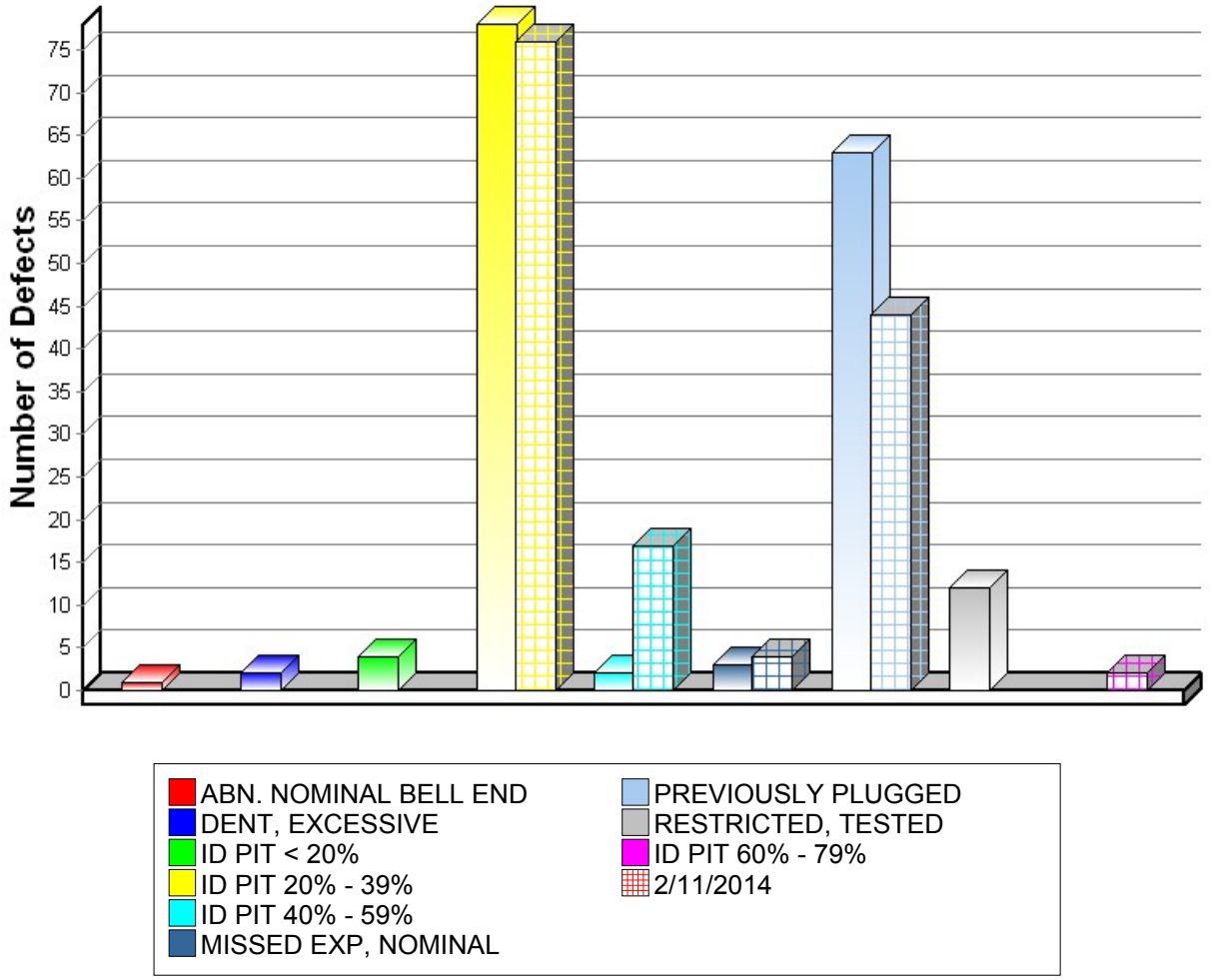
Bay 6	46.00"
Bay 5	43.00"
Bay 4	43.00"
Bay 3	43.00"
Bay 2	43.00"
Bay 1	46.00"

Defect Summary/Comparison

Comparison of Tests Performed

1/21/2019 2/11/2014

Evaporator Defects



Location	Model	Serial Number
DUPONT EXPERIMENTAL STATION	17DA743	01588 #6

Note: A graph indicating the number of tubes marked for each category will be generated when tubes are marked. Indications from previous inspections will be displayed as cross hatch bars.

Summary of Inspection

An eddy current tube inspection was performed as part of a preventive maintenance program with the following results.

Evaporator: 2586 Tubes		
Tubes Tested: 2586 Tubes		
Significant/Measurable Indications	Tubes Marked	Percent of Bundle
ABN. NOMINAL BELL END	1	.04
DENT, EXCESSIVE*	2	.08
MISSED EXP, NOMINAL	3	.12
ID PIT < 20%	4	.15
ID PIT 20% - 39%	78	3.02
ID PIT 40% - 59%*	2	.08
PREVIOUSLY PLUGGED	63	2.44
RESTRICTED, TESTED	12	.46
Totals	**165**	**6.39**

* REQUIRES ACTION

Recommendations

An eddy current inspection was performed on the tubes in this machine. This test was performed using accepted eddy current test methods for the inspection of in-service tubing. It should be noted that Eddy Current is not a leak detection method. The possibility does exist that tubes could contain defects and/or leaks which are not detectable. If leaks are suspected, we recommend a pressure test be used to identify the leaking tubes.

The following suggested repair actions are based on accepted industry standards. After removing sample tubes to confirm the inspection results, a determination of corrective action should be made by the repair agency and end user. Only these parties have knowledge of the critical applications and long-term use of the equipment. If plugging is selected over replacement, both efficiency and capacity should be considered.

EVAPORATOR:

The tube indicating Abnormal Bell End Indications requires no corrective action at this time. However, the exact cause of the anomaly is unknown. If a leak is suspected, we recommend this tube be pressure tested and/or isolated from the system.

We recommend tubes indicating Excessive Dents be isolated from the system. Due to the size and location of the dents these tubes could not be tested with the size probe normally used. These tubes were tested using a smaller diameter probe. A dent can mask a potentially significant defect indication, and/or act as a stress riser which could lead to a stress related tube failure.

Tubes marked as Missed Expanded require no corrective action at this time.

Tubes indicating ID Pits of 40% or more should be isolated from the system at this time. ID Pits of less than 40% require no immediate corrective action. However, this type damage is usually progressive and should be monitored.

Tubes marked as Previously Plugged, had been plugged prior to this inspection.

Tubes marked as Restricted/Tested contained foreign material or other obstructions and could not be tested with the size probe normally used. These tubes were tested using a smaller diameter probe. No tube damage was detected. It should be noted that using a smaller probe can increase inspection noise, and reduce sensitivity.

RE-INSPECTION RECOMMENDATIONS:

We recommend that a follow-up inspection be performed on these vessels as follows:

Evaporator: 23 January 2020

A copy of this report should be retained in your files to be used for comparison at that time.

If you should have any questions concerning this report, or if we may be of further assistance, please feel free to call upon us.

Data Sheet

Location	Model	Serial Number	Date
DUPONT EXPERIMENTAL STATION	17DA743	01588 #6	January 21, 2019
200 POWER MILL ROAD			
WILMINGTON, DE 19803			

Row	Tube	Description	Area	Action Req.
SET UP CALIBRATE & STARTED				
EVAPORATOR 1/21/2019 08:58 am				
1	18	ID PIT 20% - 39%	B06	
1	20	PREVIOUSLY PLUGGED	TE	
1	60	PREVIOUSLY PLUGGED	TE	
1	68	PREVIOUSLY PLUGGED	TE	
1	71	PREVIOUSLY PLUGGED	TE	
2	51	ID PIT 20% - 39%	B02	
3	28	PREVIOUSLY PLUGGED	TE	
3	36	PREVIOUSLY PLUGGED	TE	
3	63	MISSED EXP, NOMINAL	S04	
3	73	PREVIOUSLY PLUGGED	TE	
4	34	PREVIOUSLY PLUGGED	TE	
5	35	PREVIOUSLY PLUGGED	TE	
5	44	ID PIT 20% - 39%	B06	
6	68	ID PIT 20% - 39%	B04	
7	12	ID PIT < 20%	B04	
7	17	ID PIT 20% - 39%	B03	
7	23	PREVIOUSLY PLUGGED	TE	
7	59	ID PIT 20% - 39%	B02	
7	62	ID PIT 20% - 39%	B04	

Row	Tube	Description		Area	Action Req.
8	9	ID PIT < 20%		B06	
8	31	ID PIT 20% - 39%		B06	
8	39	ID PIT 20% - 39%		B06	
8	58	ID PIT 20% - 39%		B03	
9	47	ID PIT 20% - 39%		B03	
9	70	ID PIT 20% - 39%		B03	
10	4	ID PIT 20% - 39%		B05	
10	10	PREVIOUSLY PLUGGED		TE	
10	28	PREVIOUSLY PLUGGED		TE	
10	40	PREVIOUSLY PLUGGED		TE	
10	43	ID PIT 20% - 39%		B03	
10	62	ID PIT 20% - 39%		B02	
10	64	ID PIT 40% - 59%	**Plugged by JCI - 01/25/2019**	B03	✓
CALIBRATION CHECK 1/21/2019 02:26 pm					
CALIBRATION CHECK 1/22/2019 07:52 am					
11	24	PREVIOUSLY PLUGGED		TE	
11	67	DENT, EXCESSIVE	**Plugged by JCI - 01/25/2019**	B04	✓
11	68	DENT, EXCESSIVE	**Plugged by JCI - 01/25/2019**	B03	✓
12	24	ID PIT 20% - 39%		B03	
12	56	PREVIOUSLY PLUGGED		TE	
12	58	PREVIOUSLY PLUGGED		TE	
12	70	ID PIT 20% - 39%		B02	
13	3	PREVIOUSLY PLUGGED		TE	
13	21	ID PIT 20% - 39%		B01	
13	22	ID PIT 20% - 39%		B06	
13	31	ID PIT 20% - 39%		B06	

Row	Tube	Description	Area	Action Req.
13	48	ID PIT 20% - 39%	B06	
13	50	PREVIOUSLY PLUGGED	TE	
13	51	PREVIOUSLY PLUGGED	TE	
13	65	ID PIT 20% - 39%	B01	
14	5	PREVIOUSLY PLUGGED	TE	
14	9	PREVIOUSLY PLUGGED	TE	
14	18	ID PIT 20% - 39%	B02	
14	21	ID PIT 20% - 39%	B03	
14	38	PREVIOUSLY PLUGGED	TE	
14	52	ID PIT 20% - 39%	B04	
14	56	PREVIOUSLY PLUGGED	TE	
14	61	ID PIT 20% - 39%	B01	
14	67	PREVIOUSLY PLUGGED	TE	
14	74	PREVIOUSLY PLUGGED	TE	
14	75	ID PIT 20% - 39%	B05	
15	9	PREVIOUSLY PLUGGED	TE	
15	51	ID PIT 20% - 39%	B06	
15	54	PREVIOUSLY PLUGGED	TE	
15	58	ID PIT 20% - 39%	B05	
16	8	PREVIOUSLY PLUGGED	TE	
16	9	ID PIT 20% - 39%	B03	
16	12	ID PIT 20% - 39%	B03	
16	25	PREVIOUSLY PLUGGED	TE	
16	26	PREVIOUSLY PLUGGED	TE	
16	28	PREVIOUSLY PLUGGED	TE	
16	36	ID PIT 20% - 39%	B01	

Row	Tube	Description	Area	Action Req.
16	48	ID PIT 20% - 39%	B05	
16	54	PREVIOUSLY PLUGGED	TE	
16	65	ID PIT 20% - 39%	B06	
16	68	PREVIOUSLY PLUGGED	TE	
17	2	ID PIT 20% - 39%	B02	
17	45	ID PIT 20% - 39%	B05	
17	53	ID PIT 20% - 39%	B05	
17	68	PREVIOUSLY PLUGGED	TE	
17	70	RESTRICTED, TESTED	TE	
18	14	PREVIOUSLY PLUGGED	TE	
18	27	PREVIOUSLY PLUGGED	TE	
18	35	PREVIOUSLY PLUGGED	TE	
18	38	RESTRICTED, TESTED	TE	
18	51	ID PIT 20% - 39%	B04	
18	59	PREVIOUSLY PLUGGED	TE	
18	60	RESTRICTED, TESTED	TE	
18	69	RESTRICTED, TESTED	TE	
19	1	PREVIOUSLY PLUGGED	TE	
19	2	PREVIOUSLY PLUGGED	TE	
19	3	PREVIOUSLY PLUGGED	TE	
19	7	PREVIOUSLY PLUGGED	TE	
19	8	ID PIT 20% - 39%	B05	
19	22	PREVIOUSLY PLUGGED	TE	
19	39	ID PIT 20% - 39%	B02	
19	46	ID PIT 20% - 39%	B02	
19	47	ID PIT 20% - 39%	B01	

Row	Tube	Description	Area	Action Req.
19	56	ID PIT 20% - 39%	B06	
19	61	ID PIT 20% - 39%	B05	
19	66	ID PIT 20% - 39%	B04	
20	53	ID PIT 20% - 39%	B05	
20	61	ID PIT 20% - 39%	B02	
20	71	ID PIT 20% - 39%	B06	
21	6	PREVIOUSLY PLUGGED	TE	
21	36	RESTRICTED, TESTED	TE	
21	44	RESTRICTED, TESTED	TE	
21	54	ID PIT 20% - 39%	B05	
21	56	ID PIT 20% - 39%	B05	
21	66	MISSED EXP, NOMINAL	S02	
21	68	PREVIOUSLY PLUGGED	TE	
22	35	RESTRICTED, TESTED	TE	
22	47	RESTRICTED, TESTED	TE	
22	60	RESTRICTED, TESTED	TE	
23	36	RESTRICTED, TESTED	TE	
23	56	ID PIT 20% - 39%	B05	
23	58	ID PIT 20% - 39%	B06	
24	12	ID PIT 20% - 39%	B01	
24	30	ID PIT 20% - 39%	B03	
24	37	MISSED EXP, NOMINAL	S01	
24	45	PREVIOUSLY PLUGGED	TE	
24	63	ID PIT 20% - 39%	B04	
25	11	PREVIOUSLY PLUGGED	TE	
25	14	ID PIT 20% - 39%	B03	

Row	Tube	Description	Area	Action Req.
25	18	ID PIT 20% - 39%	B04	
25	24	ID PIT 20% - 39%	B01	
25	29	ID PIT 20% - 39%	B01	
25	31	PREVIOUSLY PLUGGED	TE	
25	43	ID PIT 20% - 39%	B03	
26	4	ID PIT 20% - 39%	B02	
26	60	PREVIOUSLY PLUGGED	TE	
26	63	ID PIT 20% - 39%	B01	
26	66	PREVIOUSLY PLUGGED	TE	
27	49	ID PIT 20% - 39%	B03	
28	18	PREVIOUSLY PLUGGED	TE	
28	27	ID PIT 20% - 39%	B02	
28	29	PREVIOUSLY PLUGGED	TE	
28	42	ID PIT 20% - 39%	B02	
28	57	PREVIOUSLY PLUGGED	TE	
28	59	PREVIOUSLY PLUGGED	TE	
29	33	PREVIOUSLY PLUGGED	TE	
29	41	PREVIOUSLY PLUGGED	TE	
29	44	ID PIT 40% - 59% **Plugged by JCI - 01/25/2019**	B01	✓
29	50	ID PIT 20% - 39%	B02	
CALIBRATION CHECK 1/22/2019 03:21 pm				
CALIBRATION CHECK 1/23/2019 07:53 am				
30	13	ID PIT < 20%	B02	
30	28	ID PIT 20% - 39%	B03	
31	2	ID PIT < 20%	B06	
31	6	ID PIT 20% - 39%	B04	

Row	Tube	Description	Area	Action Req.
31	19	ID PIT 20% - 39%	B06	
32	21	ID PIT 20% - 39%	B06	
33	15	RESTRICTED, TESTED	TE	
33	36	PREVIOUSLY PLUGGED	TE	
33	39	PREVIOUSLY PLUGGED	TE	
34	3	PREVIOUSLY PLUGGED	TE	
34	9	ABN. NOMINAL BELL END	TE	
34	16	ID PIT 20% - 39%	B04	
34	18	RESTRICTED, TESTED	TE	
35	38	ID PIT 20% - 39%	B01	
36	13	ID PIT 20% - 39%	B05	
37	9	ID PIT 20% - 39%	B06	
37	11	ID PIT 20% - 39%	B01	
37	14	ID PIT 20% - 39%	B05	
37	34	ID PIT 20% - 39%	B02	
39	4	PREVIOUSLY PLUGGED	TE	
39	6	PREVIOUSLY PLUGGED	TE	
39	12	ID PIT 20% - 39%	B02	
41	12	PREVIOUSLY PLUGGED	TE	
42	9	PREVIOUSLY PLUGGED	TE	
CALIBRATION CHECK & COMPLETED				
EVAPORATOR 1/23/2019 12:47 pm				

Evaporator Section

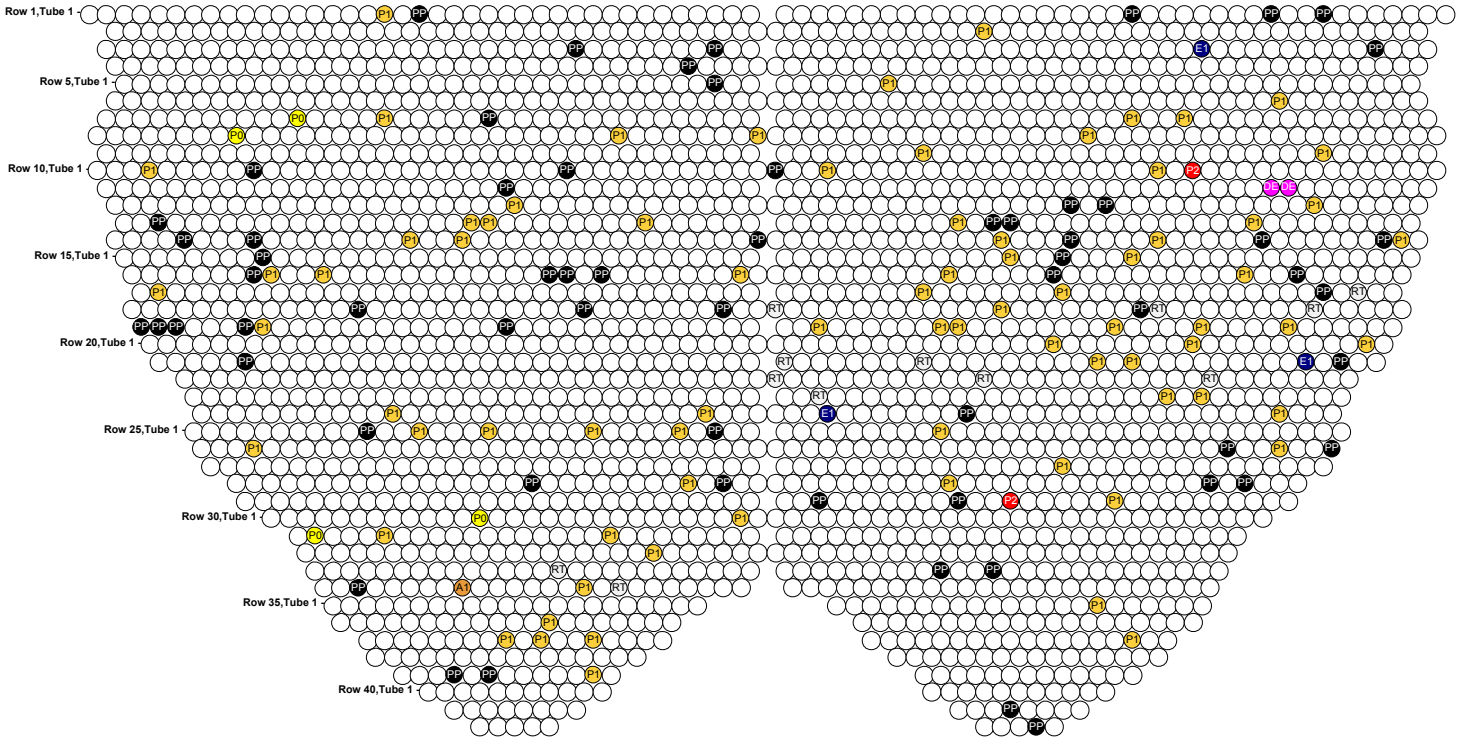
Tubes Numbered
Left to Right

Rows Numbered
Top to Bottom

Top of Vessel

S/N 01588 #6

Opposite Inlet/Outlet



A1 = ABN. NOMINAL BELL END

DE = DENT, EXCESSIVE REQUIRES ACTION

E1 = MISSED EXP, NOMINAL

P0 = ID PIT < 20%

P1 = ID PIT 20% - 39%

P2 = ID PIT 40% - 59% REQUIRES ACTION

PP = PREVIOUSLY PLUGGED

RT = RESTRICTED, TESTED

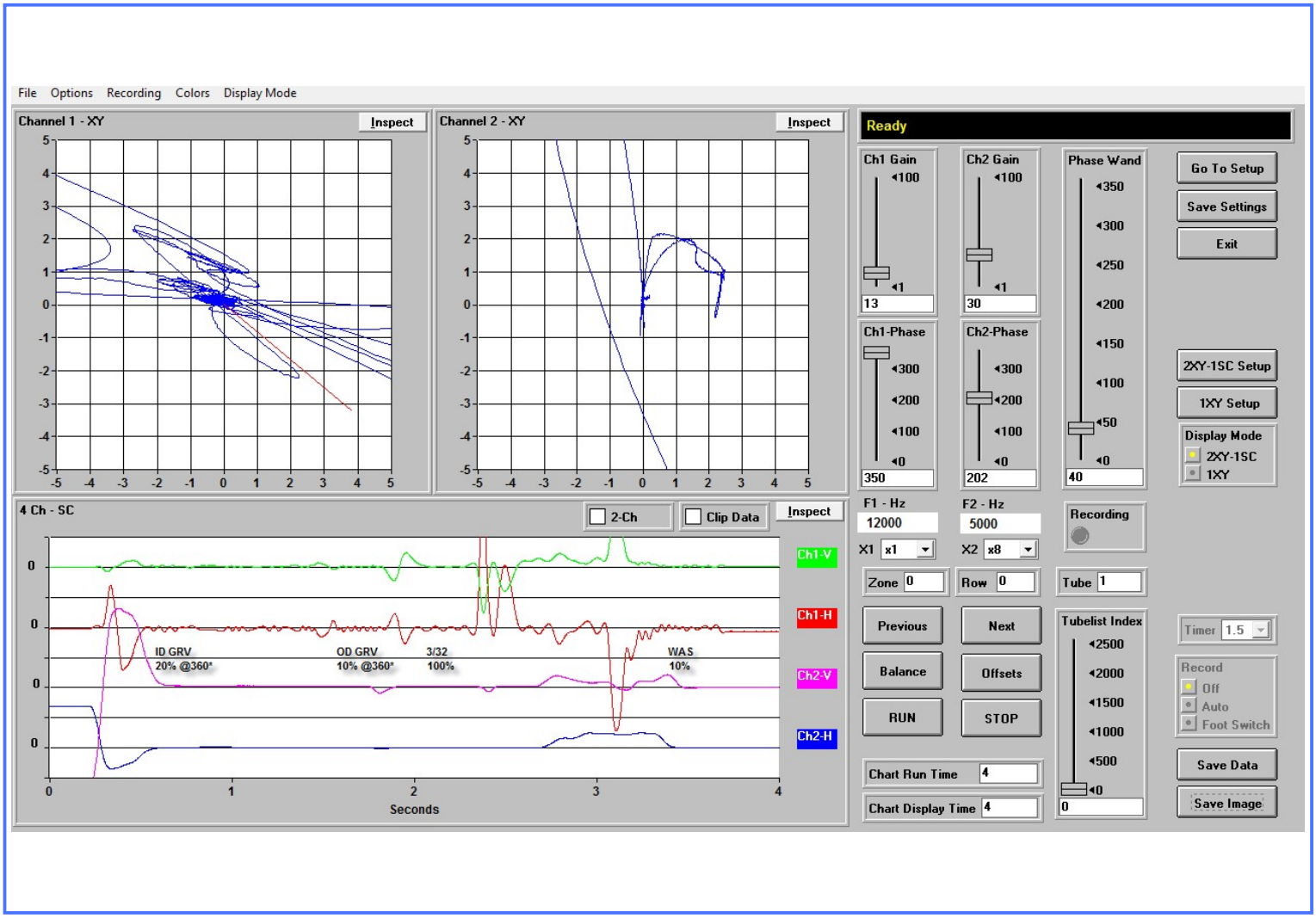
Test Instrument Used
Highline Automation, EC14

S/N 01588 #6

Calibration Page

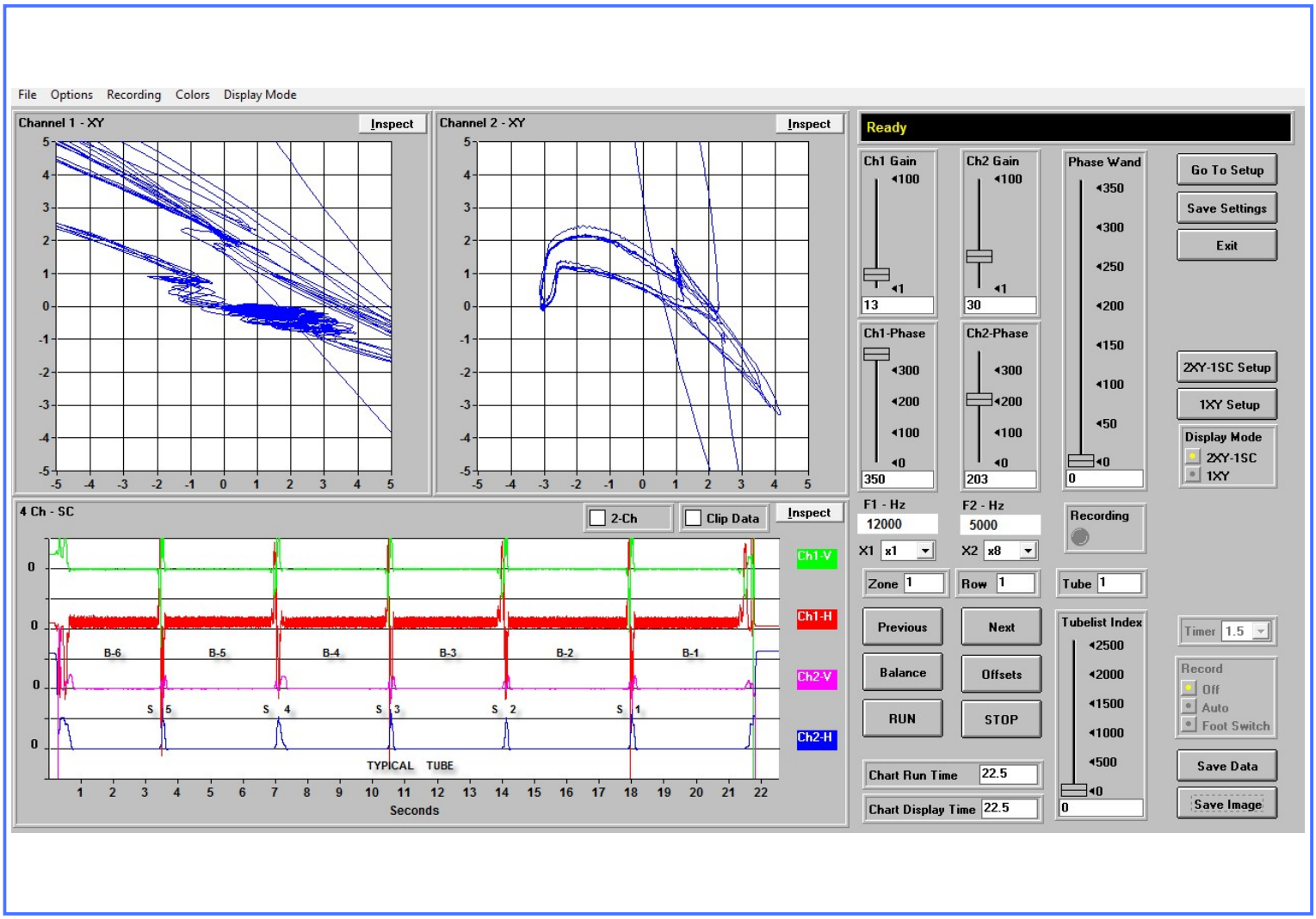
Tube Type	Material	Nom Wall Thick	End Wall Thick	OD	Test Type	Probe Diameter
Skip Fin IE	Copper	.028	.049	.750	Cross/Diff	.5625

Evaporator



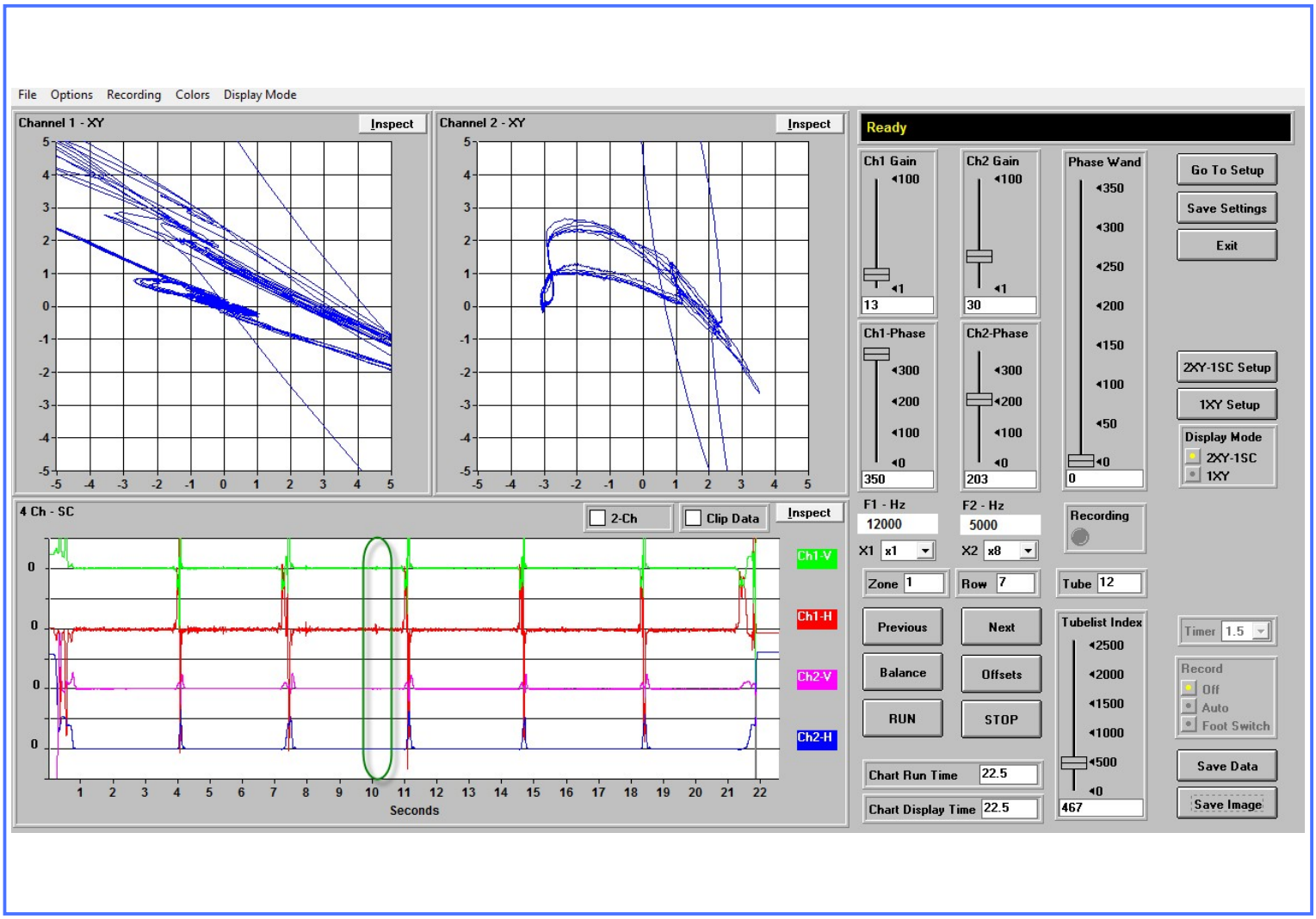
Note: Defects are compared to machined standards.
Actual Defect Geometry may differ.

Evaporator Section



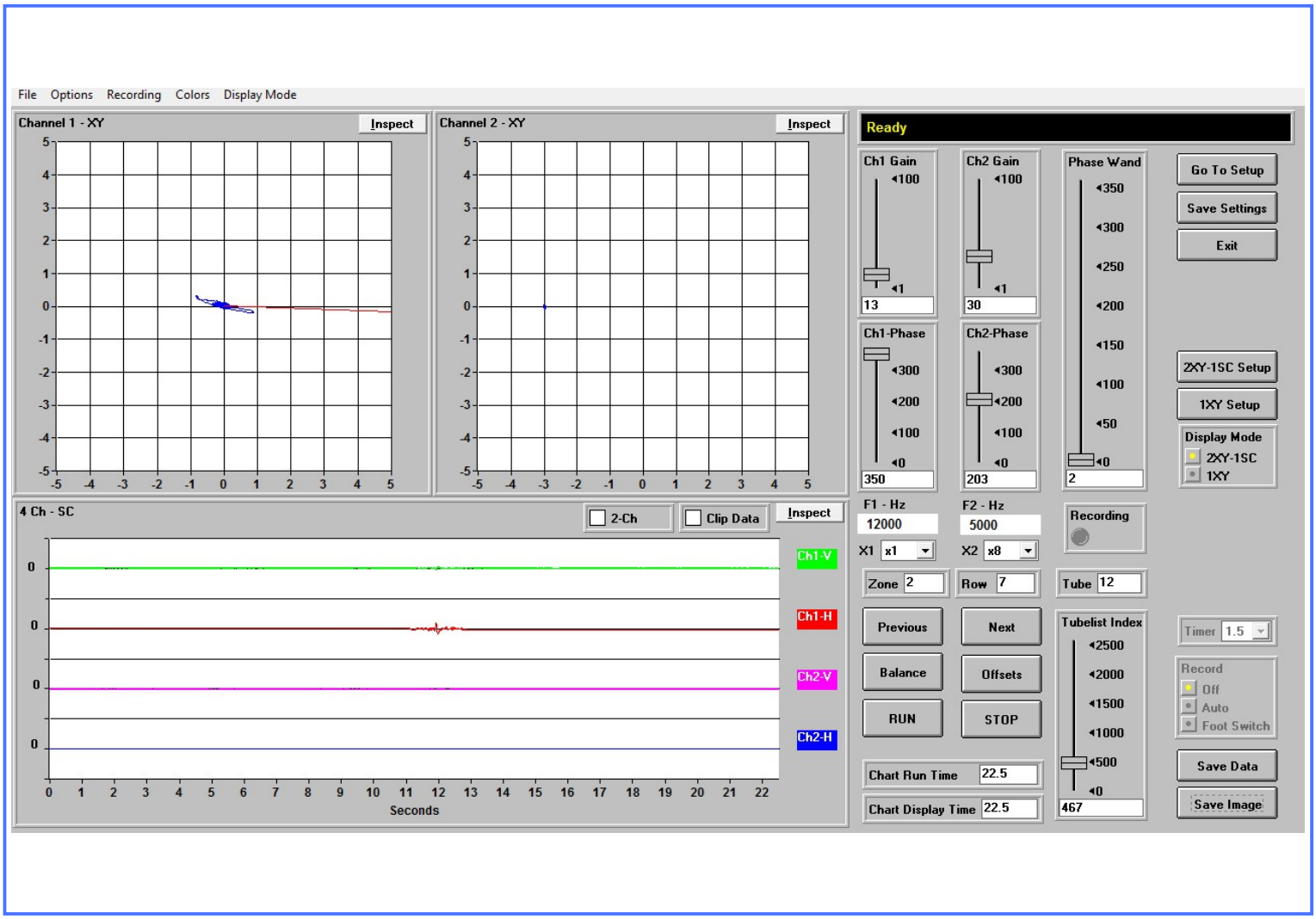
TYPICAL TUBE (Row 1 Tube 1)

Evaporator Section



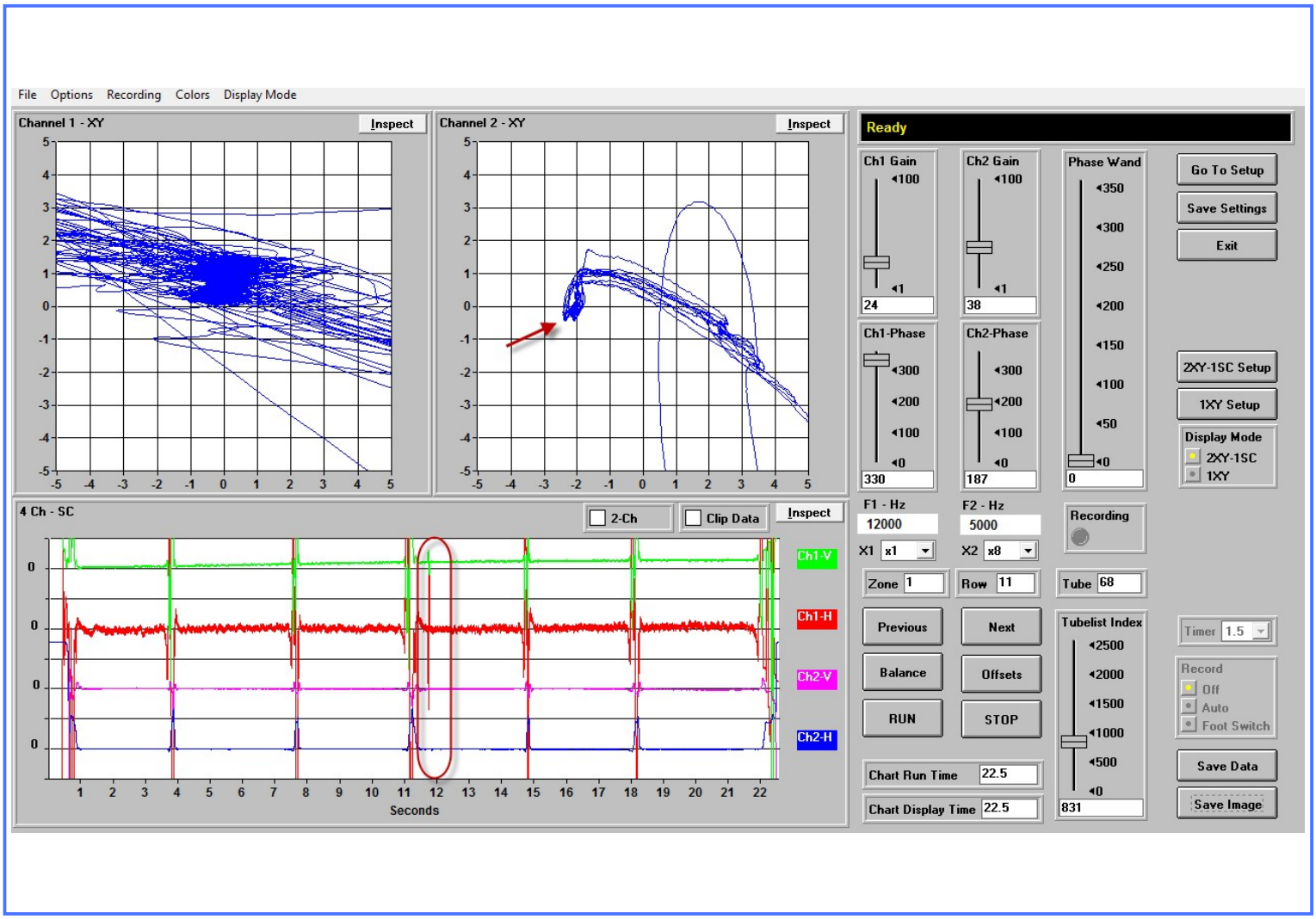
ID PIT < 20% (Row 7 Tube 12)

Evaporator Section



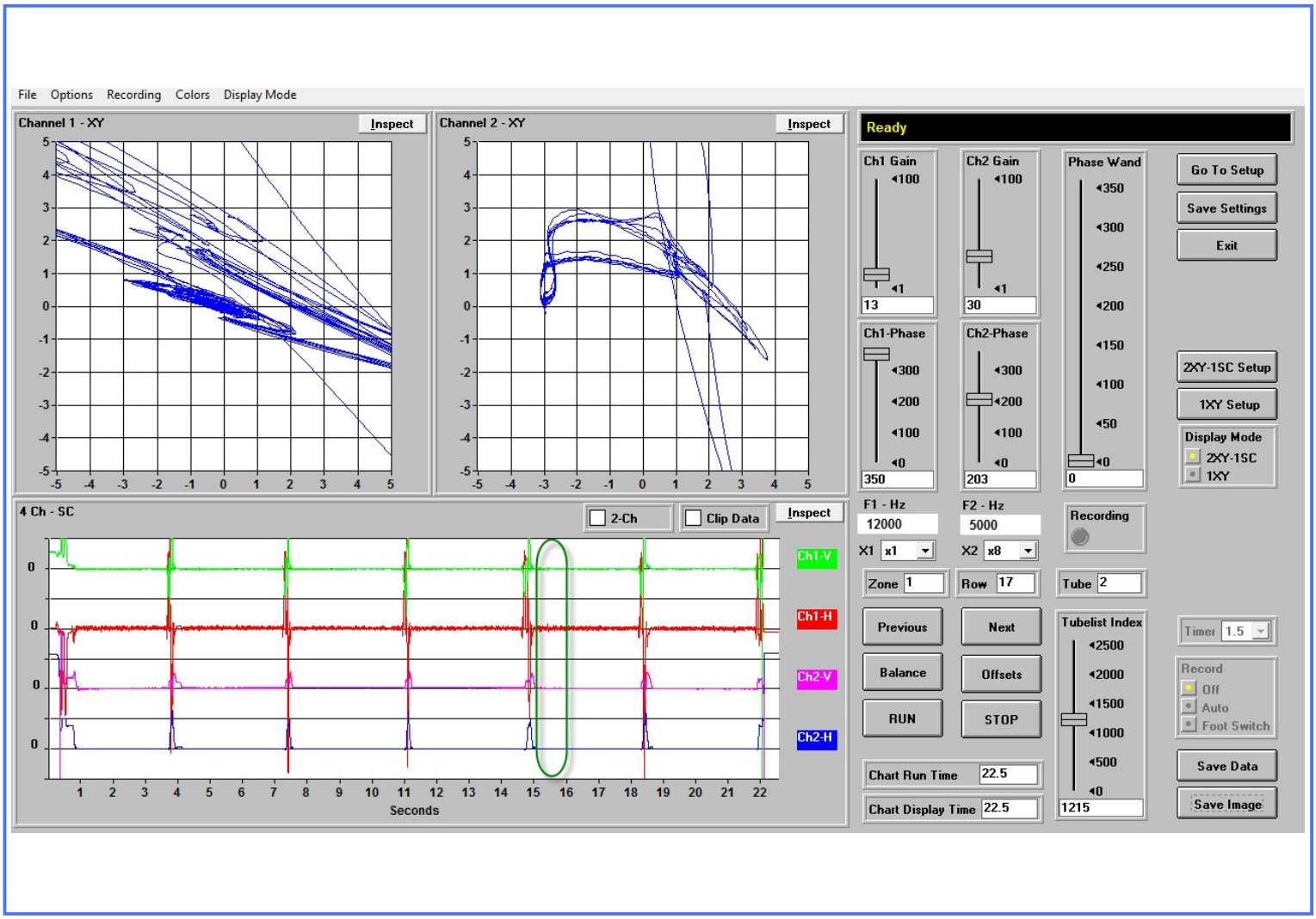
ID PIT < 20% (Row 7 Tube 12)

Evaporator Section



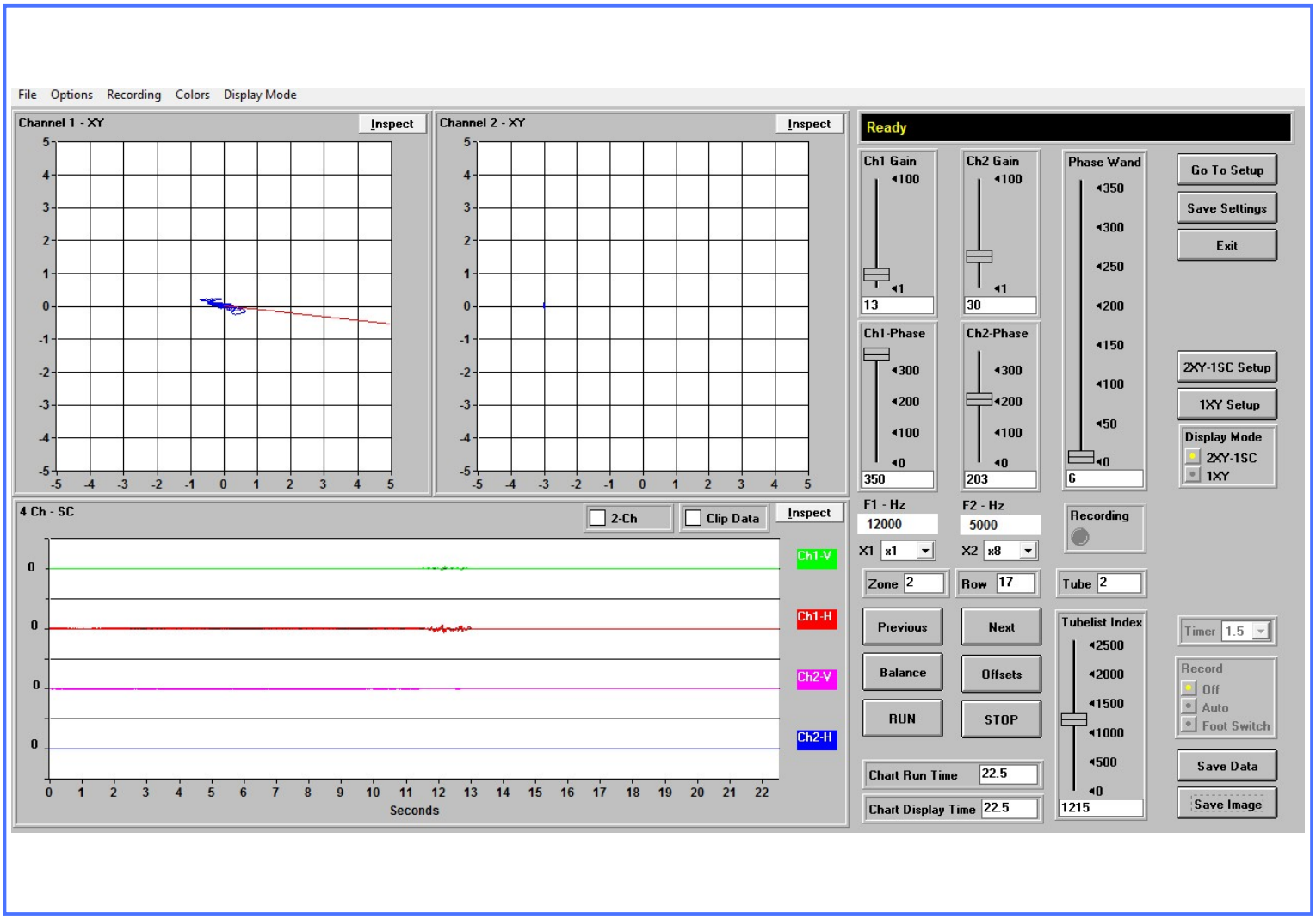
DENT, EXCESSIVE (Row 11 Tube 68)

Evaporator Section



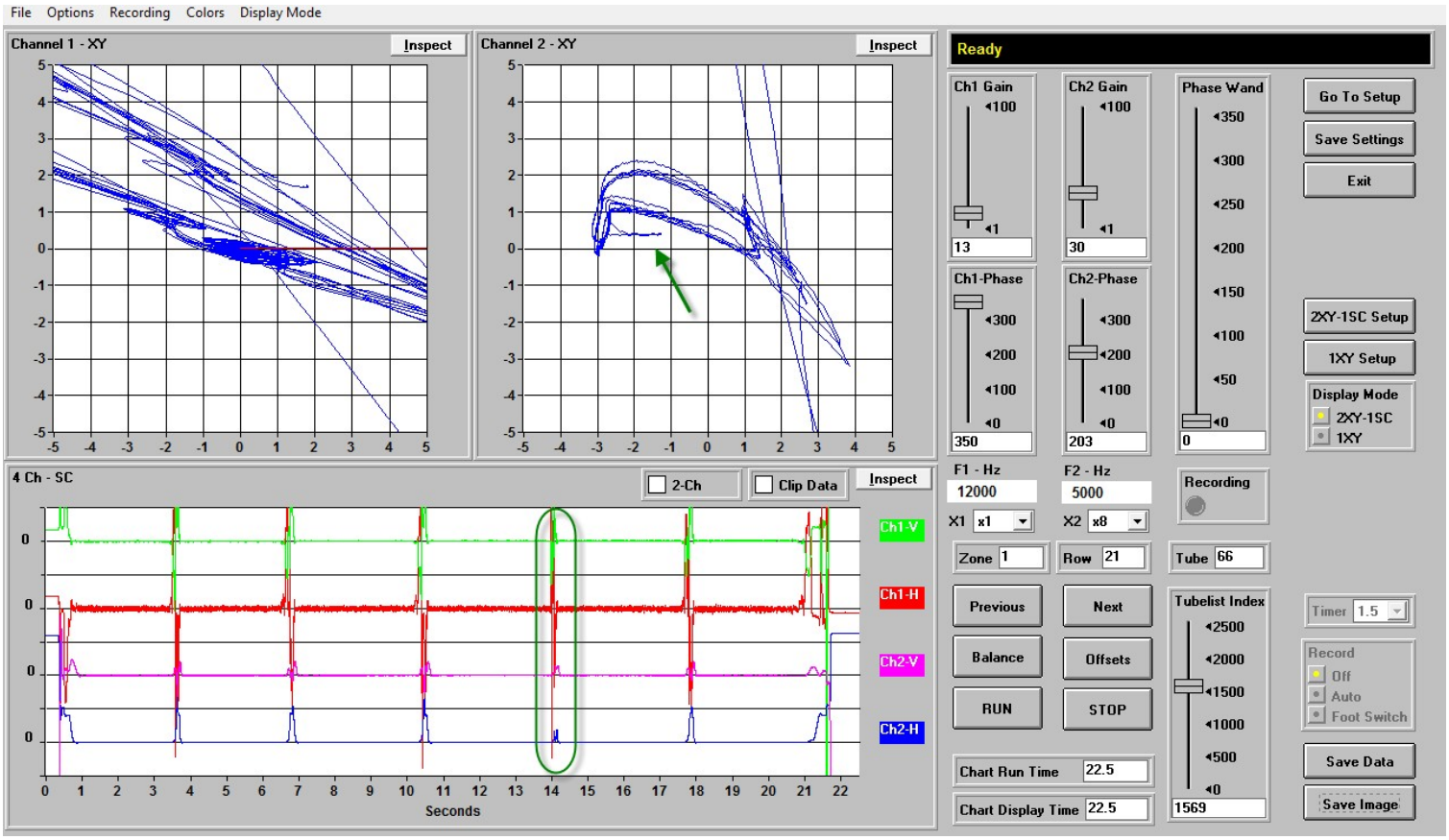
ID PIT 20% - 39% (Row 17 Tube 2)

Evaporator Section



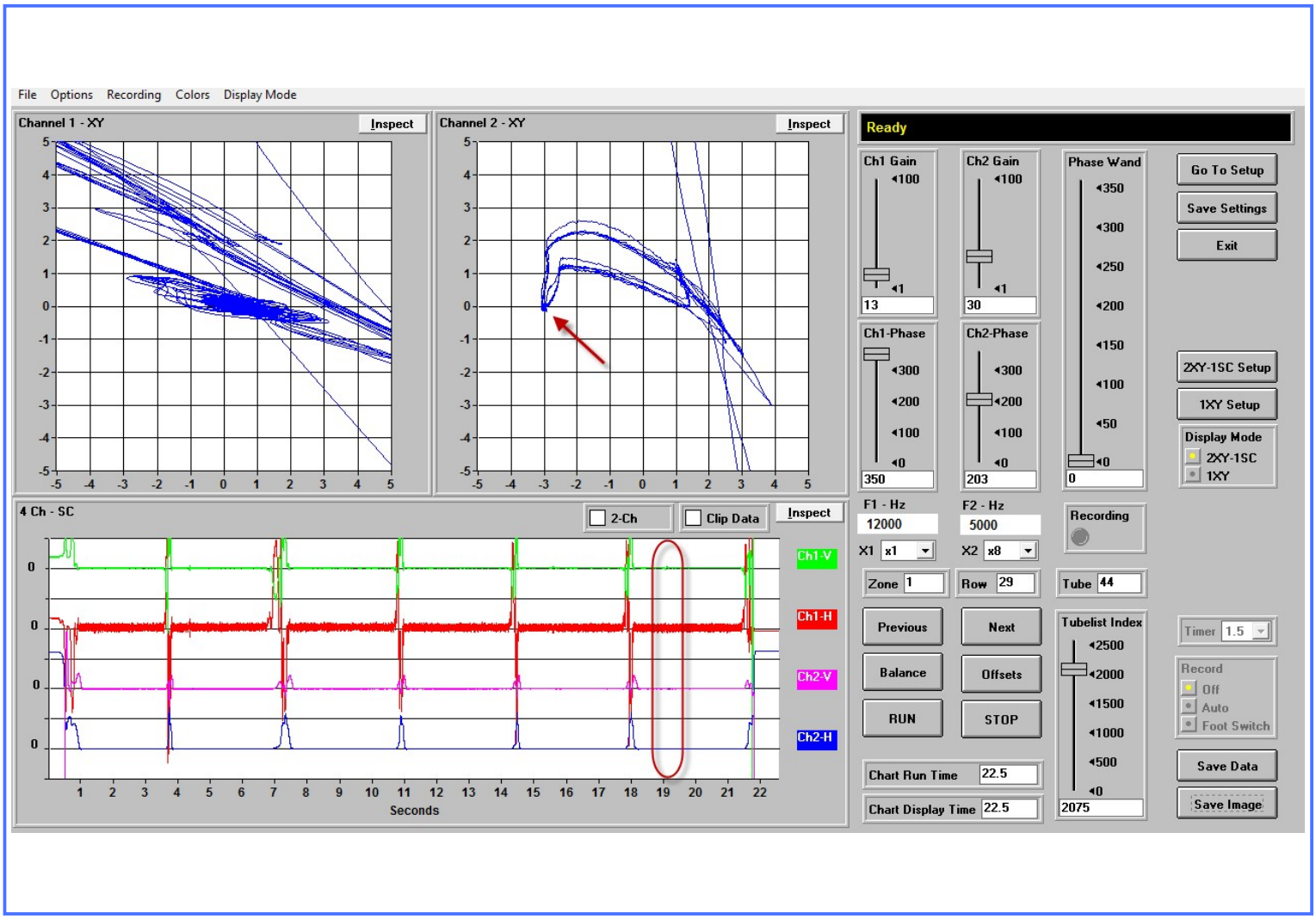
ID PIT 20% - 39% (Row 17 Tube 2)

Evaporator Section



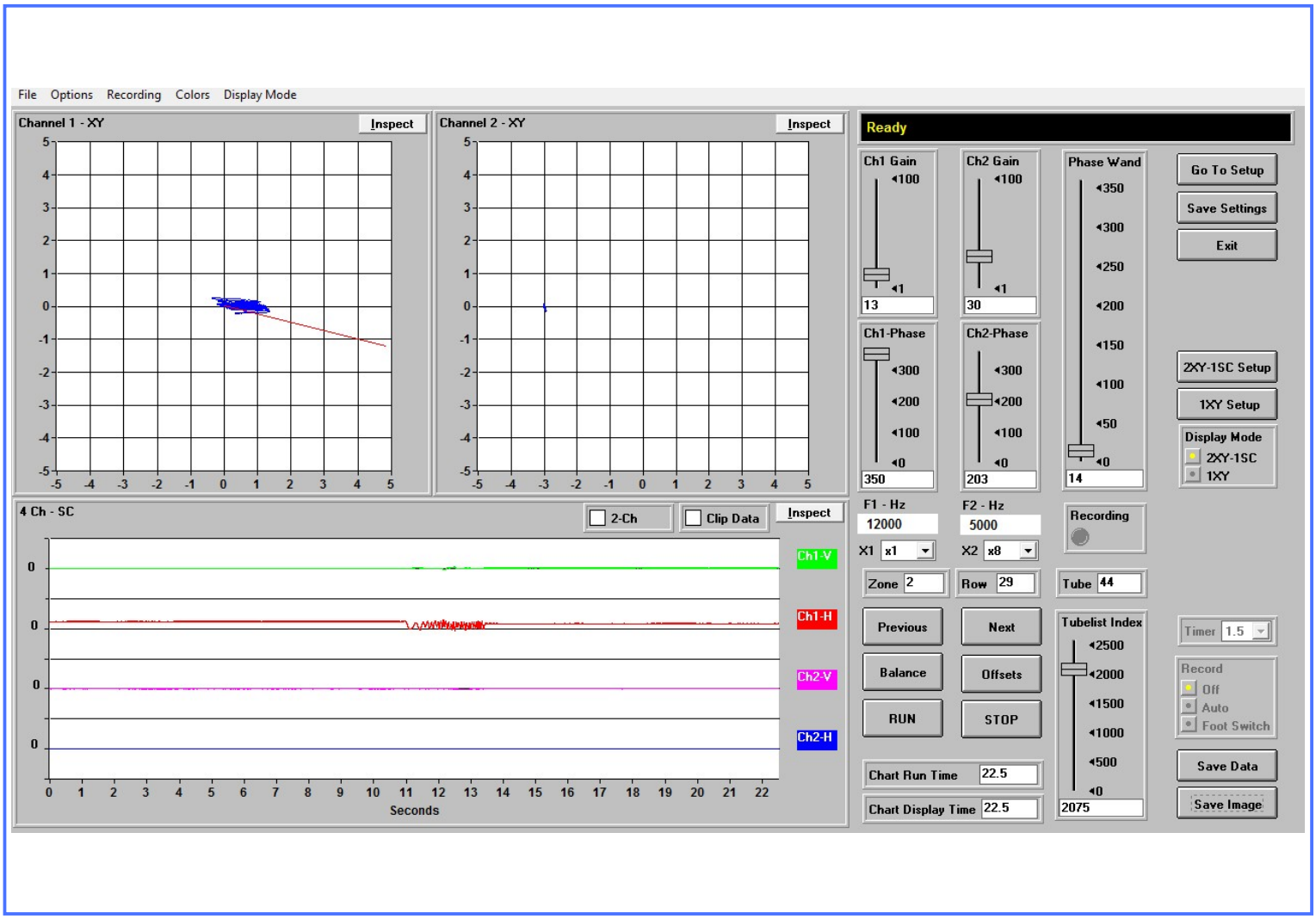
MISSED EXP, NOMINAL (Row 21 Tube 66)

Evaporator Section



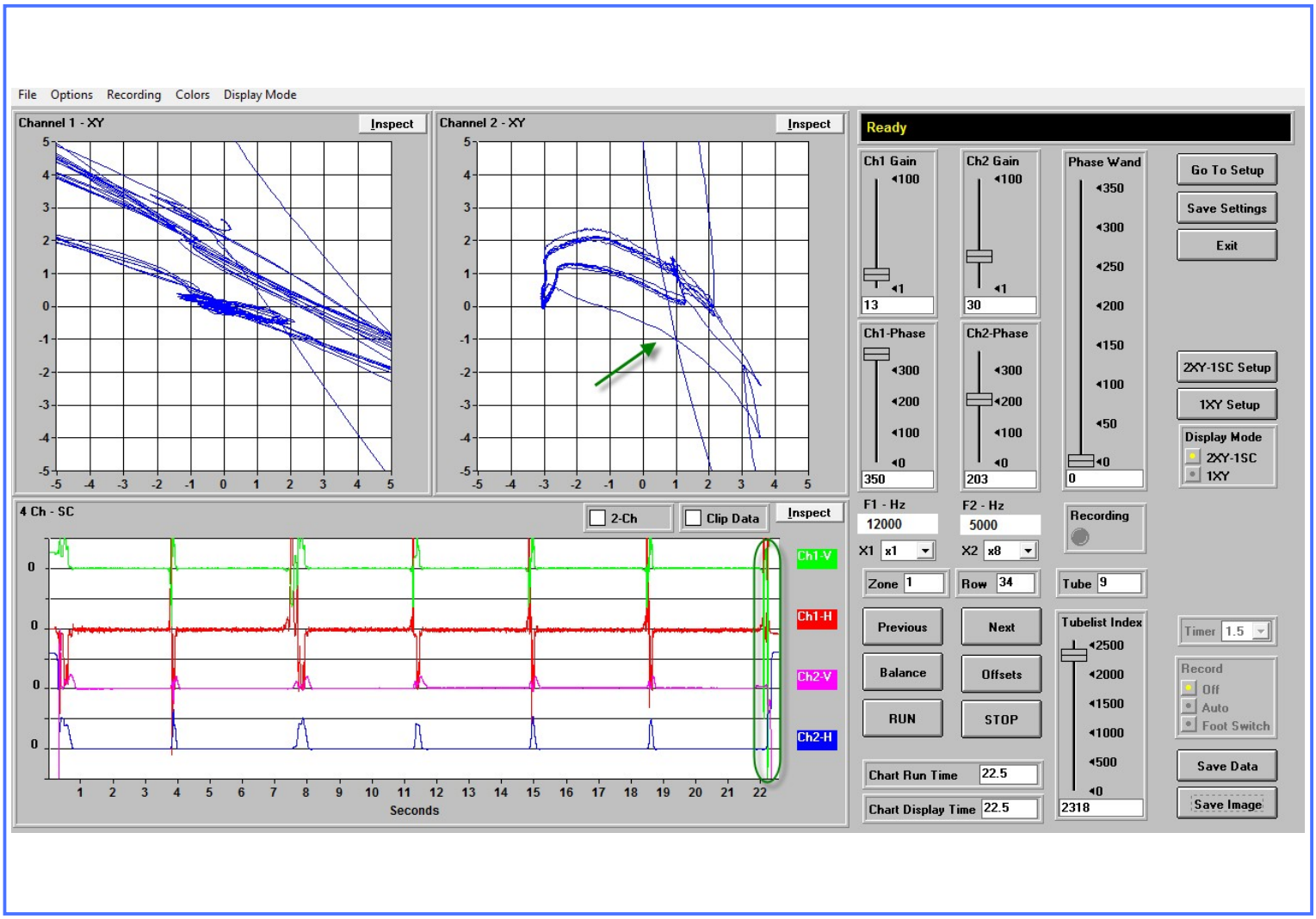
ID PIT 40% - 59% (Row 29 Tube 44)

Evaporator Section



ID PIT 40% - 59% (Row 29 Tube 44)

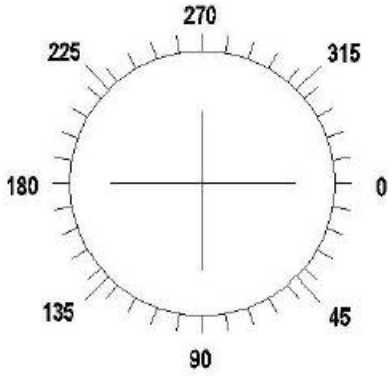
Evaporator Section

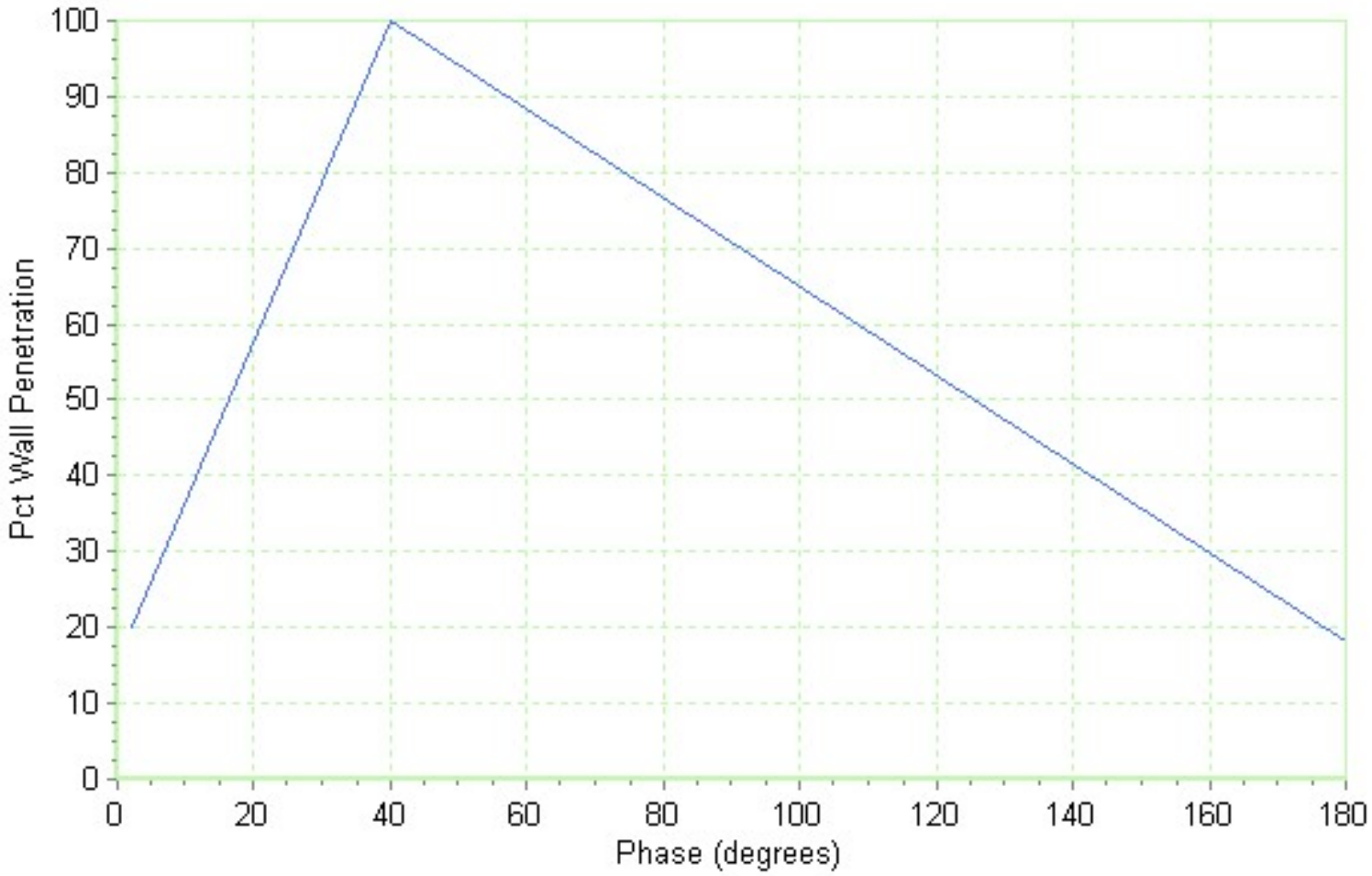


ABN. NOMINAL BELL END (Row 34 Tube 9)

Phase Chart - Evaporator

Material	Tube Type	OD	Wall	Test Type	Frequency	Probe Diameter
Copper	Skip Fin IE	.750	.049	CROSS/DIFF	12	.5625





Calibration Procedure

A calibration procedure is performed prior to an inspection, and is repeated every 2 hours, or whenever improper operation of the test instrument is suspected. Test frequencies are selected prior to an inspection through experimentation to achieve optimum phase separation, and amplitude response for the tube type and alloy being inspected. An appropriate inspection probe is selected based on tube type, wall thickness, and alloy. The inspection probe will have a minimum fill factor of 80% through the smallest areas of the tubes being inspected. Instrument sensitivity is set high enough to determine background noise inherent in the tube and to produce a .05 Volt deflection for a .031 through wall hole at .25 V/Div.

Calibration Reference Standard

A Calibration Reference Standard representing a typical production run tube of the same alloy, tube type and nominal wall thickness is used to adjust test system response. The calibration reference standard used for the inspection of finned and internally enhanced tubing, has been milled in accordance with the American Society for Testing and Materials (ASTM). Standard Recommended Practices, E-243-80, E-426-76, and E571-76. The depth of the grooves and notches used for establishing instrument response are calculated to compensate for the influence of the fins and/or internal enhancements used on finned tubes. Where applicable, calibration reference standards are milled in accordance with the American Society of Mechanical Engineers (ASME), Section V, Article 8, Appendix I.

A strip chart recording of each calibration reference standard used for the inspection has been included in this report. Each artificial discontinuity has been identified on the strip chart recording.

Explanation of Abbreviations

Abbreviation	Explanation
ABN IND	Abnormal Indication
B	Bay
FB	Freeze Bulge
FBH	Flat Bottom Hole
FM	Foreign Material
ID	Internal Diameter
ID CORROSION	Internal Diameter, Corrosion
ID DEPOSIT	Internal Diameter, Deposit
ID PIT	Internal Diameter, Pit
IDML	Internal Diameter, Metal Loss
IE	Internally Enhanced
OD	Outside Diameter
ODML	Outside Diameter, Metal Loss
ODML@S	Outside Diameter Metal Loss at Support
OD DEPOSIT	Outside Diameter, Deposit
PLF	Possible Longitudinal Flaw
PRF	Possible Radial Flaw
PSC	Possible Stress Corrosion
S	Support
WAS	Wear at Support
>	Greater Than
<	Less Than
OTE	Opposite Test End
TE	Test End